Sipex®

SP503
Application Note

- DTE and DCE configurations with the **SP503**
- Connecting the **SP503** to a DB-25 connector in DTE and DCE modes
- Implementing V.35 with the SP503
- Creating extra single-ended and differential channels with the **SP503** using the SP310A and SP485
- Using external supplies with the **SP503**

Due to its flexibility and programmability, the **SP503** has been finding its way into many new networking products. The **SP503** offers an excellent replacement for discrete solutions on X.25 implementations for frame relay systems, multi-protocol routers and other WAN products where many designs run various modes such as RS-232, RS-422, V.35 or V.36.

For RS-232, the older bipolar 1488 and 1489 parts, or even the newer MAX230 or SP230 series have traditionally been used. For RS-422 or RS-485, the 26LS31, 26LS32, 3488, and 3489 have been seen in many designs. These parts have been also

used for V.35 but with external termination resistors. For a typical design, four RS-232 chips would be used for a complete RS-232 port, four RS-422 chips for an RS-422 port and four chips for V.35 with an external resistor network. Port programmability would require relays or switches so that software lines can control whether RS-232 is active or RS-422 is active. The relays increase board capacity as well as cost to the design.

The **SP503** solves board space and cost problems by offering a single packaged part that supports various protocols and also offers software programmability to the port.
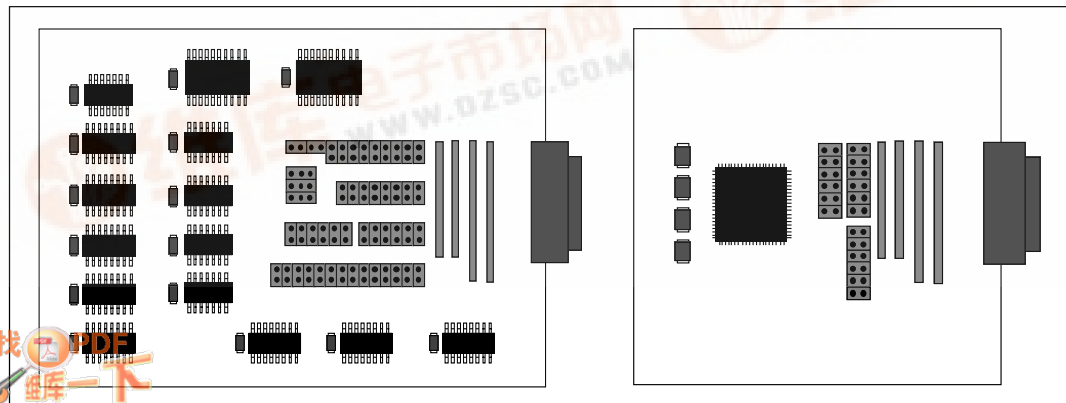
Typical discrete solution vs. the SP503

DTE and DCE configurations with the SP503

The **SP503** has designated signals such as "Transmit Data", "Clear-to-Send", etc. which designers can easily allocate the appropriate **SP503** transceivers for the corresponding signals. The data signals specified in the EIA standards and CCITT are referenced in the **SP503** datasheet as DTE. Some customers have wondered if they can use the **SP503** for DCE applications. Although it can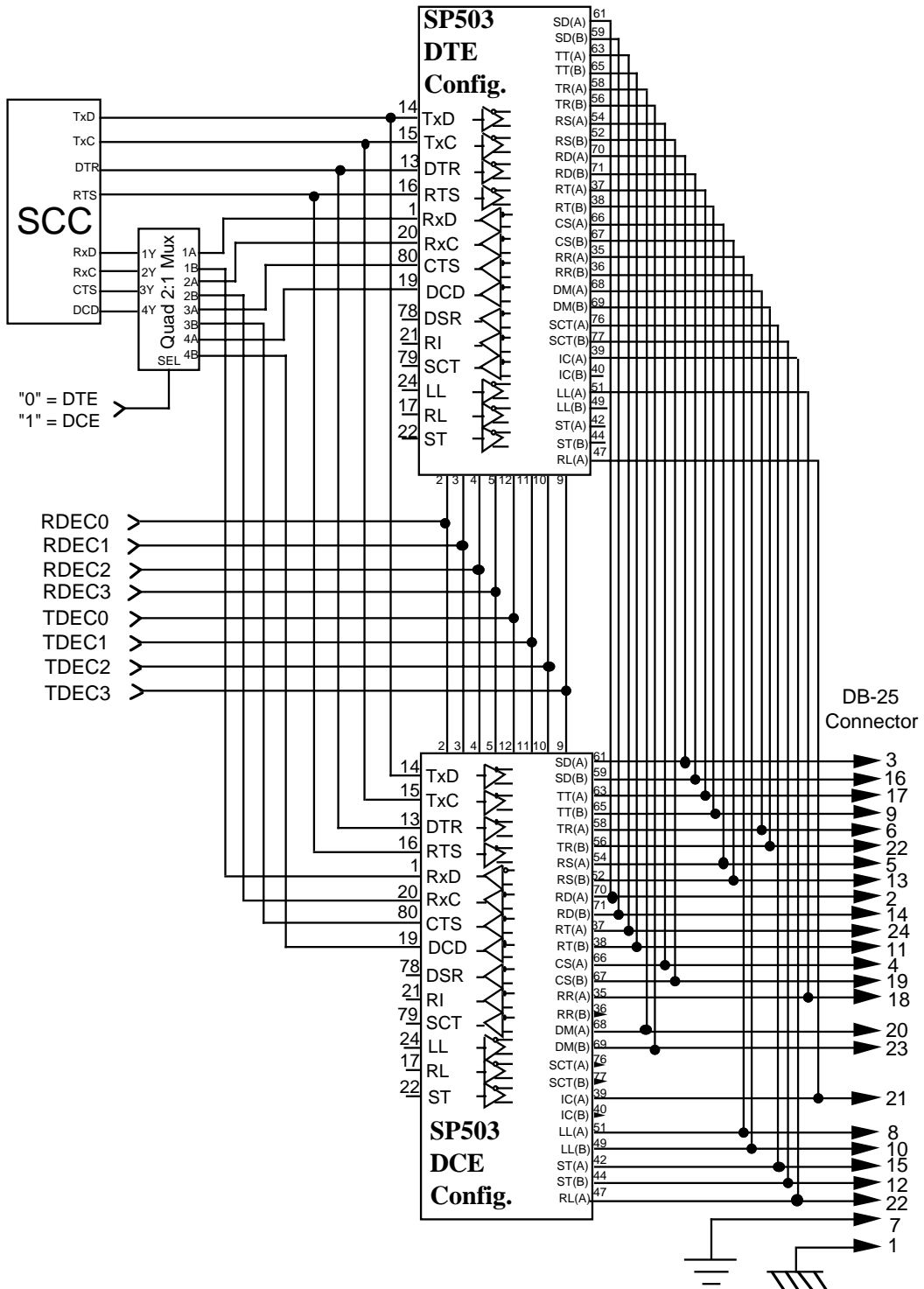 be confusing at first glance, the DCE implementation is the mirror image of the DTE side. For the DTE, TxD is a driver which drives the data to RxD, a receiver, on the DCE side. TxC or TT is a driver on the DTE side which drives the clock signal to the RxC receiver on the DCE side.

The next three pages illustrate the CCITT signal allocations from the **SP503** in either DTE or DCE to the DB-25 connector. As shown, it is possible to use a DB-25 connector for the various protocols offered by the **SP503**.
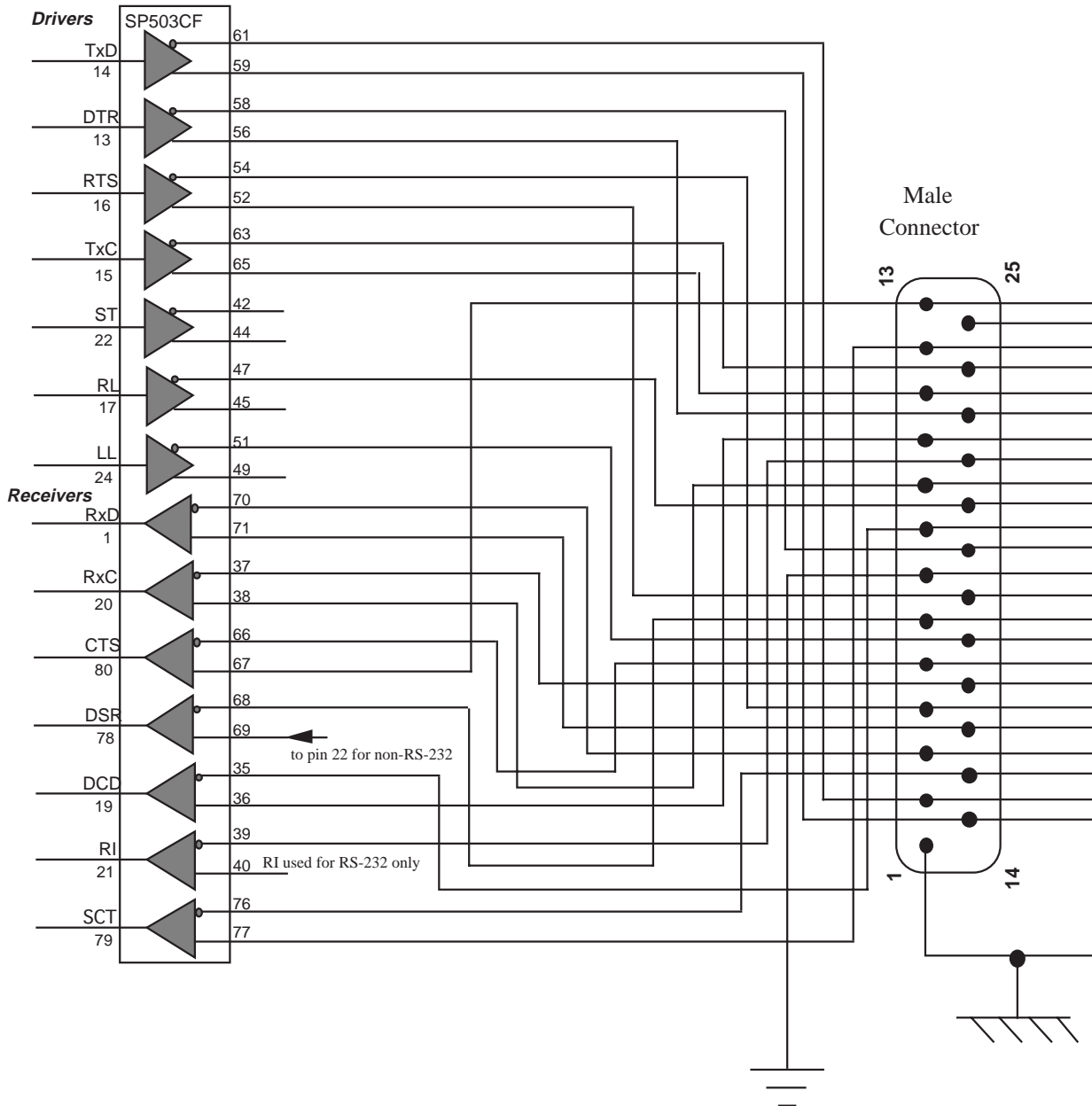
DB-25 Connector Pin Assignments for Various Protocols

DB-25 Pin #	RS-232	EIA-530	RS-449	RS-422	V.35	V.36
1	shield	shield	shield	shield	CCITT# 101	CCITT# 101
2	TxD	TxD(A)	SD(A)	T(A)	103(A)	103(A)
3	RxD	RxD(A)	RD(A)	R(A)	104(A)	104(A)
4	RTS	RTS(A)	RS(A)	C(A)	105	105(A)
5	CTS	CTS(A)	CS(A)	–	106	106(A)
6	DSR	DSR(A)	DM(A)	–	107	107(A)
7	Signal GND	Signal GND	Signal GND	Signal GND	102	102
8	DCD	RLSD(A)	RR(A)	I(A)	109	109(A)
9	–	RxC(B)	RT(B)	–	115(B)	115(B)
10	–	RLSD(B)	RR(B)	I(B)`	–	109(B)
11	–	TxC(B-DTE)	TT(B)	–	113(B)	113(B)
12	DCD (2nd)	TxCC(B-DCE)	ST(B)	S(B)	114(B)	114(B)
13	CTS (2nd)	CTS(B)	CS(B)	–	–	106(B)
14	TxD (2nd)	TxD(B)	SD(B)	T(B)	103(B)	103(B)
15	TxCC (DCE)	TxCC(A-DCE)	ST(A)	S(A)	114(B)	114(B)
16	RxD (2nd)	RxD(B)	RD(B)	R(B)	104(B)	104(B)
17	RxC	RxC(A)	RT(A)	–	115(A)	115(A)
18	LL	LL	LL	–	–	141
19	RTS (2nd)	RTS(B)	RS(B)	C(B)	–	105(B)
20	DTR	DTR(A)	TR(A)	–	–	–
21	RL	RL	RL	–	–	140
22	RI	DSR(B)	DM(B)	–	–	107(B)
23	SRS	DTR(B)	TR(B)	–	–	–
24	TxC (DTE)	TxC(A-DTE)	TT(A)	–	113(A)	113(A)

DTE-DCE flexibility with the SP503 on a DB-25 serial port

SP503
DTE
Config.

SCC

TxD
TxC
DTR
RTS

RxD
RxC
CTS
DCD

Quad 2:1 Mux

1Y 1A
2Y 1B
3Y 2A
4Y 2B
3A
3B
4A
SEL 4B

"0" = DTE
"1" = DCE

14 TxD
15 TxC
13 DTR
16 RTS
1 RxD
20 RxC
80 CTS
19 DCD
78 DSR
21 RI
79 SCT
24 LL
17 RL
22 ST

SD(A) 61
SD(B) 59
TT(A) 63
TT(B) 65
TR(A) 58
TR(B) 56
RS(A) 54
RS(B) 52
RD(A) 70
RD(B) 71
RT(A) 37
RT(B) 38
CS(A) 66
CS(B) 67
RR(A) 35
RR(B) 36
DM(A) 68
DM(B) 69
SCT(A) 76
SCT(B) 77
IC(A) 39
IC(B) 40
LL(A) 51
LL(B) 49
ST(A) 42
ST(B) 44
RL(A) 47

2 3 4 5 12 11 10 9

RDEC0
RDEC1
RDEC2
RDEC3
TDEC0
TDEC1
TDEC2
TDEC3

DB-25
Connector

2 3 4 5 12 11 10 9

14 TxD
15 TxC
13 DTR
16 RTS
1 RxD
20 RxC
80 CTS
19 DCD
78 DSR
21 RI
79 SCT
24 LL
17 RL
22 ST

SD(A) 61
SD(B) 59
TT(A) 63
TT(B) 65
TR(A) 58
TR(B) 56
RS(A) 54
RS(B) 52
RD(A) 70
RD(B) 71
RT(A) 37
RT(B) 38
CS(A) 66
CS(B) 67
RR(A) 35
RR(B) 36
DM(A) 68
DM(B) 69
SCT(A) 76
SCT(B) 77
IC(A) 39
IC(B) 40
LL(A) 51
LL(B) 49
ST(A) 42
ST(B) 44
RL(A) 47

SP503
DCE
Config.

3
16
17
9
6
22
5
13
2
14
24
11
4
19
18
20
23

21

8
10
15
12
22
7
1

Driver / Receiver Connections to a DB-25 Connector

DTE Mode

Drivers — SP503CF

Signal	Pin	Driver pins
TxD	14	61 / 59
DTR	13	58 / 56
RTS	16	54 / 52
TxC	15	63 / 65
ST	22	42 / 44
RL	17	47 / 45
LL	24	51 / 49

Receivers

Signal	Pin	Receiver pins
RxD	1	70 / 71
RxC	20	37 / 38
CTS	80	66 / 67
DSR	78	68 / 69
DCD	19	35 / 36
RI	21	39 / 40
SCT	79	76 / 77

to pin 22 for non-RS-232

RI used for RS-232 only

Male Connector

13   25

1   14

Driver / Receiver Connections to a DB-25 Connector

DCE Mode

SP503CF

Receivers

Signal	Pin		Receiver	Pin
TxD(A)	70		RxD	1
TxD(B)	71			
TxC(A)	37		RxC	20
TxC(B)	38			
RTS(A)	66		CTS	80
RTS(B)	67			
DTR(A)	68		DSR	78
DTR(B)	69			
LL	35		DCD	19
	36			
RL	39		RI	21
	40			
	76		SCT	79
	77			

Drivers

Signal	Pin		Driver	Pin
RxD(A)	61		TxD	14
RxD(B)	59			
DSR(A)	58		DTR	13
to pin 22 for non-RS-232	56			
CTS(A)	54		RTS	16
CTS(B)	52			
RxC(A)	63		TxC	15
RxC(B)	65			
SCT(A)	42		ST	22
SCT(B)	44			
RI	47		RL	17
	45			
DCD(A)	51		LL	24
DCD(B)*	49			

Female Connector

25 13

14 1

* The non-inverting LL driver output is not a
valid driver output for RS-449 and EIA-530.

SP503 V.35 External Termination Resistors

V.35 implementation requires external resistors to be connected to the driver outputs and receiver inputs. The resistors are needed for reducing signal levels and maintaining input and output impedance levels that conform to CCITT Recommendation V.35. The drawings below offer both receiver input termination and driver output termination configurations that will comply to V.35.
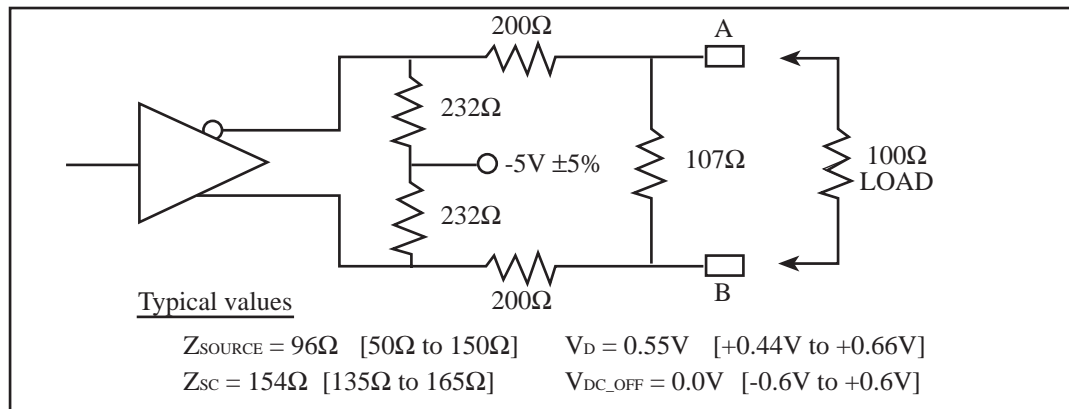
As you may know, the termination resistors are for V.35 mode only and have to be disconnected when another mode is programmed. There are a few ways to connect and disconnect the network. One method is to add a daughter-card option slot onto the main printed circuit board where the **SP503** is mounted. This allows the user to add a mini-PC card that contains the V.35

network to be connected to the driver outputs and receiver inputs. Another method is to implant the V.35 network into a cable if the user requires conversion cables to switch from one protocol to another. For example, if the serial port has a DB-25 connector and requires an ISO-2593 connector for V.35; a DB-25 to ISO-2593 conversion cable containing the V.35 network is connected to the port.

Of course this method will not allow programmability to the serial port if the user wants to run various protocols to that port. To actively switch protocols by software control, you can use analog switches or relays. **Sipex** recommends using low-ON resistance analog switches, such as Siliconix DG643© analog switches for the driver outputs, and solid-state relays such as the AT&T LH1514© for the receiver inputs. See opposite page for an example of the **SP503** V.35 configuration. For other termination networks, please consult the factory.
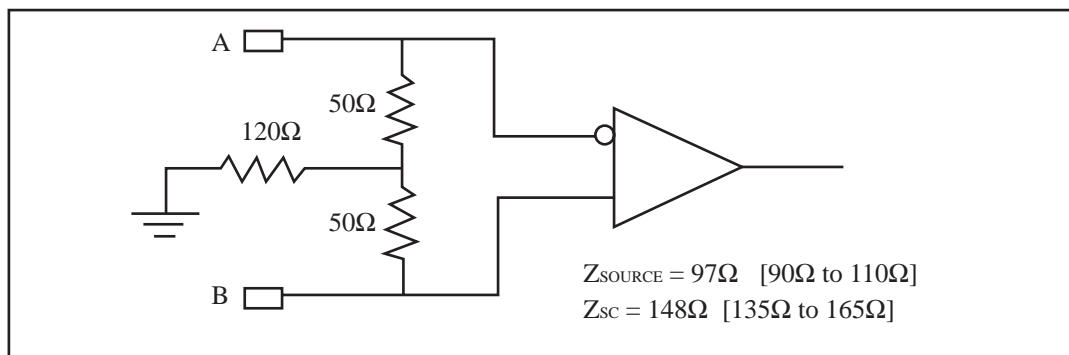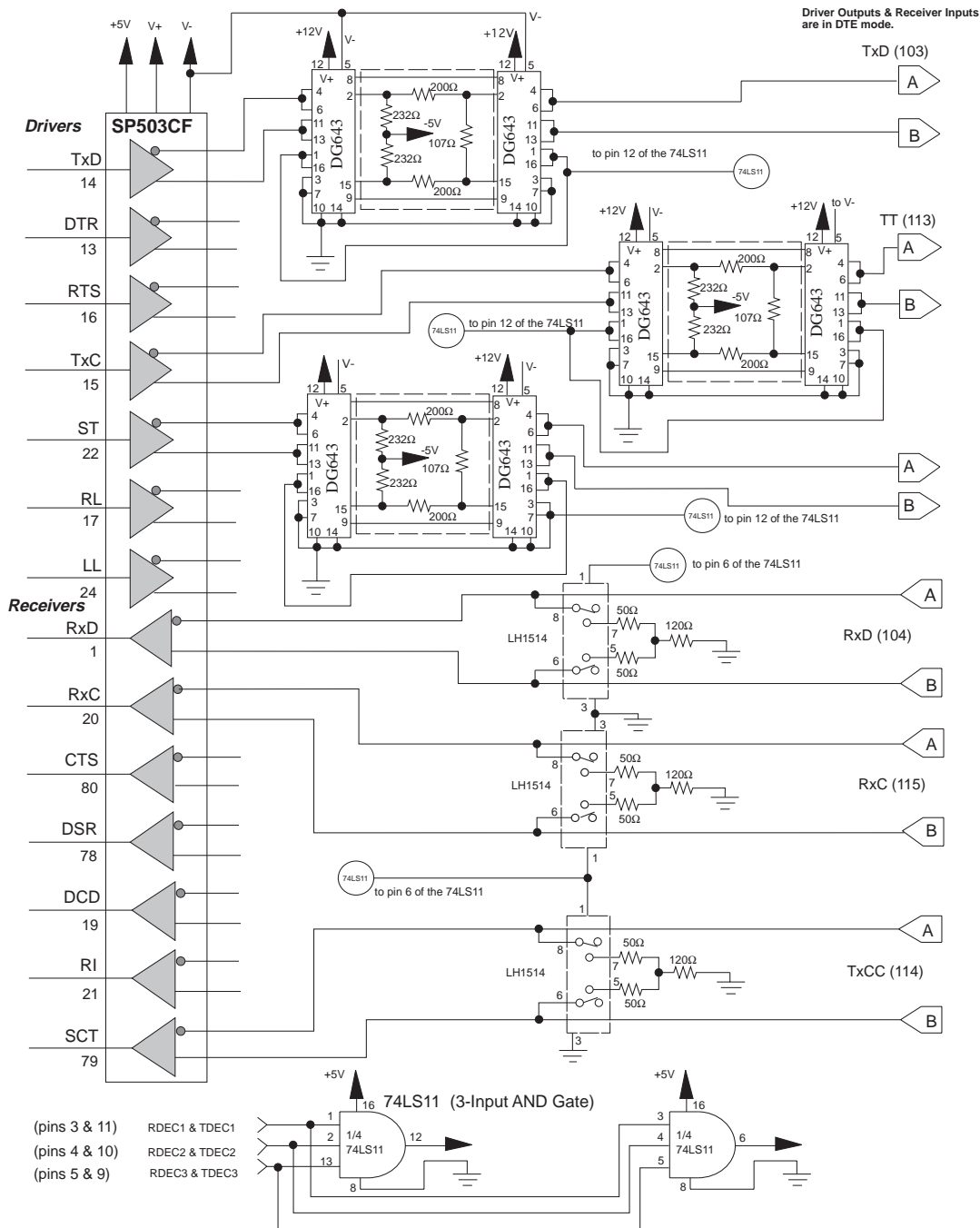

V.35 Receiver Input Termination Resistor Network

$Z_{SOURCE} = 97\Omega$ $[90\Omega$ to $110\Omega]$
$Z_{SC} = 148\Omega$ $[135\Omega$ to $165\Omega]$

V.35 Driver Output Termination Resistor Network

Typical values

$Z_{SOURCE} = 96\Omega$ $[50\Omega$ to $150\Omega]$ $V_D = 0.55V$ $[+0.44V$ to $+0.66V]$
$Z_{SC} = 154\Omega$ $[135\Omega$ to $165\Omega]$ $V_{DC\_OFF} = 0.0V$ $[-0.6V$ to $+0.6V]$

SP503 Switching Configuration for V.35 Implementations

- Switches are **Siliconix DG643DY** analog switches.
- Solid-State Relays are **AT&T, LH1514**.
- Resistors are 1/8W, 1% tolerance.
- External Supplies necessary are: V_{cc} = +5V, V+ = +12V (for V+ on the DG643DY) and V_n = -5V.

Driver Outputs & Receiver Inputs are in DTE mode.

+5V V+ V-

Drivers

SP503CF

TxD 14

DTR 13

RTS 16

TxC 15

ST 22

RL 17

LL 24

Receivers

RxD 1

RxC 20

CTS 80

DSR 78

DCD 19

RI 21

SCT 79

+12V V-   +12V

DG643   DG643

200Ω
232Ω -5V
107Ω
232Ω
200Ω

TxD (103)
A
B

to pin 12 of the 74LS11   74LS11

+12V V-   +12V to V-

DG643   DG643

200Ω
232Ω -5V
107Ω
232Ω
200Ω

TT (113)
A
B

74LS11 to pin 12 of the 74LS11

+12V V-   +12V V-

DG643   DG643

200Ω
232Ω -5V
107Ω
232Ω
200Ω

A
B

74LS11 to pin 12 of the 74LS11

74LS11 to pin 6 of the 74LS11

LH1514
50Ω
120Ω
50Ω

A
RxD (104)
B

LH1514
50Ω
120Ω
50Ω

A
RxC (115)
B

74LS11
to pin 6 of the 74LS11

LH1514
50Ω
120Ω
50Ω

A
TxCC (114)
B

+5V

74LS11 (3-Input AND Gate)

(pins 3 & 11) RDEC1 & TDEC1
(pins 4 & 10) RDEC2 & TDEC2
(pins 5 & 9)   RDEC3 & TDEC3

1/4 74LS11

+5V

1/4 74LS11

Typical Applications Questions on the SP503

Can the **SP503** be used with external power supplies? If so, is there a power-up sequence?
The internal charge pump can be bypassed through external supplies to V_{DD} and V_{SS}. The external voltage should be +10V for V_{DD} and -10V for V_{SS}. The tolerance is ±5%. The absolute minimum limit for the external supplies is ±7V and the absolute maximum limit is ±10.5V. The **SP503** does require a power-up sequence of +10V, +5V, -10V for proper operation. Additional external circuitry will be required for the correct sequencing. Consult factory for details.

What is the maximum input voltage applied to the receiver input without damaging the **SP503**?
The receiver inputs can tolerate up to ±16V in any protocol without latching up the device. Since RS-232 ranges from ±5V to ±15V; the **SP503** is well within the accepted range. It may be worthwhile to include 15V clamping diodes or transient voltage suppressors so that the receiver input will be held below ±15V.

What is the maximum short-circuit voltage that can be applied to a **SP503** driver output?
The driver outputs can be shorted up to ±16.0V without causing damage to the driver. Between the ±16V range, the **SP503** adheres to the RS-232 short circuit current limit of 100mA and to the RS-422/RS-423 limit at 150mA. Again, transient voltage suppressors or clamping diodes will protect the **SP503** if exceeding the ±16V range is possible.

What is the state of the **SP503** drivers and receivers when the device is addressed with 0000?
The **SP503** drivers are in a high impedance(over 1MΩ) tri-state condition when "0000" is addressed. The receivers are not tri-stated and the outputs are undefined. This means that they could be floating to either a high or low level depending on the previous state of the receiver input prior to the 0000 addressing change. The receiver input impedance is at 15kΩ for "0000".

Can the **SP503** be programmed for 7 drivers and 7 receivers in RS-423 mode?

The **SP503** can be switched to RS-423 mode by programming $TDEC_3$, $TDEC_2$, $TDEC_1$, $TDEC_0$ to "1000" for the drivers and $RDEC_X$ to "1000" for the receivers. However, external supplies must be used in order to drive RS-423. The internal charge pump can only support up to three RS-423 drivers and three RS-423 receivers.

What is the power dissipation in the **SP503** and in which mode does it consume the most power?
The **SP503** dissipates approximately 400mW to 1.4W depending on the protocol. RS-485 mode consumes the most power at 1.4W. For worst case power dissipation, all seven drivers were driven with a TTL signal and the outputs were looped back into the receiver inputs to generate a TTL output. All drivers and receivers were active.

MODE	P_D
RS-232	0.418W
RS-422	0.970W
RS-485	1.382W
RS-449	0.959W
EIA-530	0.959W
V.35	1.055W

What is the state of the **SP503** drivers and receivers when the device is addressed with 1111?
The address for "1111" is not used in the **SP503**. If the **SP503** is programmed for "1111", the drivers are approximately 1.0V and at a high impedance (approx. 9MΩ). The receivers are not tri-stated and the outputs are undefined. All receiver inputs are at 15kΩ input impedance. The **SP503** can receive a "1111" address while V_{CC} is off. The supply current is approximately 50mA (V_{CC} = +5V) while the address is at "1111".

In the RS-232 signal assignments for the DB-25 connector, where does the **SP503** account for Test Mode (TM) ?
For most RS-232 applications, the signals commonly used are TxD, TxC, RxD, RxC, RTS, CTS, DSR, SG, DCD, DTR and Frame Ground.

In DTE mode; TxD, TxC, RTS, DTR are the drivers and RxD, RxC, CTS, DSR, DCD are the receivers. Since there are seven drivers and seven receivers in the **SP503**, the designer can easily use the **SP503** for the above signals. Other RS-232 applications will support diagnostic functions such as LL (driver), RL (driver), and TM (receiver) which may or may not require extra transceivers depending if other signals are not used. Since Test Mode (TM) is a receiver for DTE designs, the Ring Indicator (RI) receiver in the **SP503** (pin 21) can be used for TM if RI is not used. If all the available drivers and receivers are used in the **SP503**, then another RS-232 transceiver can be added. See page 230 and 231 for suggestions on adding **Sipex's** RS-232 and RS-485 transceivers.

Are the Schottky diodes used from Vcc to Vss and from Vdd to C2- in the **SP502** necessary for the **SP503**?
Sipex has incorporated the Schottky diodes (needed with the **SP502**) into the **SP503** in order to protect against potential start up problems due to fast rate of rise on $V_{CC} (\geq 1V/\mu s)$ and overvoltage to the TTL inputs. However, a negative voltage ($V_{in} \leq -5V$) applied to the receiver inputs while the **SP503** is powered off will cause start-up problems to the charge pump. In order to guard against this condition, an external Schottky diode should be placed from V_{CC} to V_{DD} to minimize V_{CC} current injection into the IC substrate and allow the charge pump to operate properly. See page 203 *Figure 6* - Typical Operating Circuit, for diode connection schematic.

Can the **SP503** be configured for V.36?
CCITT Recommendation V.36 is similar to RS-449 where certain signals are RS-422 signals and others are RS-423. Depending on different applications; "Transmit Data", "Terminal Timing", "Request-to-Send", "Data Terminal Ready", "Receive Data", "Transmit Clock", "Receive Clock", "Clear-to-Send", "Data Carrier Detect", and "DataSet Ready" are specified as Category 1 Circuits where the protocol is RS-422 for rates over 20kbps. All other circuits are Category 2 Circuits which are specified as RS-423 circuits. Depending on particular signals, the **SP503** can be easily used for V.36.

When the two drivers, ST and TT, are in tri-state mode, what will the driver outputs tolerate for maximum short circuit voltages? And the receiver, SCT, input?
The driver outputs will tolerate up to ±16.0V without any damage to the circuit regardless of whether or not ST and TT are in tri-state mode. The tri-state circuitry does not affect the short circuit protection on the driver outputs. The SCT receiver input will tolerate up to ±16.0V without any damage to the input structure regardless of whether or not SCT is in tri-state mode.

What does Sipex recommend for transient voltage suppression techniques for the **SP503**?
For our evaluation boards, **Sipex** uses transient voltage suppressor ICs from ProTek Devices, model numbers LCA05C to LCA15C. The two digits in the part number pertain to the rated stand-off voltage, V_{WM}, which is the maximum working DC voltage applied to the device. These TVS devices are especially designed for serial data communications because of their low capacitance and low impedance. However, please be aware that V_{WM} values below the specified input range of the transceiver will affect the input impedance. For example, it would be fine to use a 5V V_{WM} value for RS-422 but for RS-232, the receiver input voltage range is ±15V where lower V_{WM} voltages will drive the impedance to ground. Another recommended manufacturer is AVX Corporation TransGuard series of TVS components. AVX offers a variety of surface mount back-to-back diodes.
ProTek Devices • P.O. Box 3129 • Tempe, AZ. 85280 • 602-431-8101
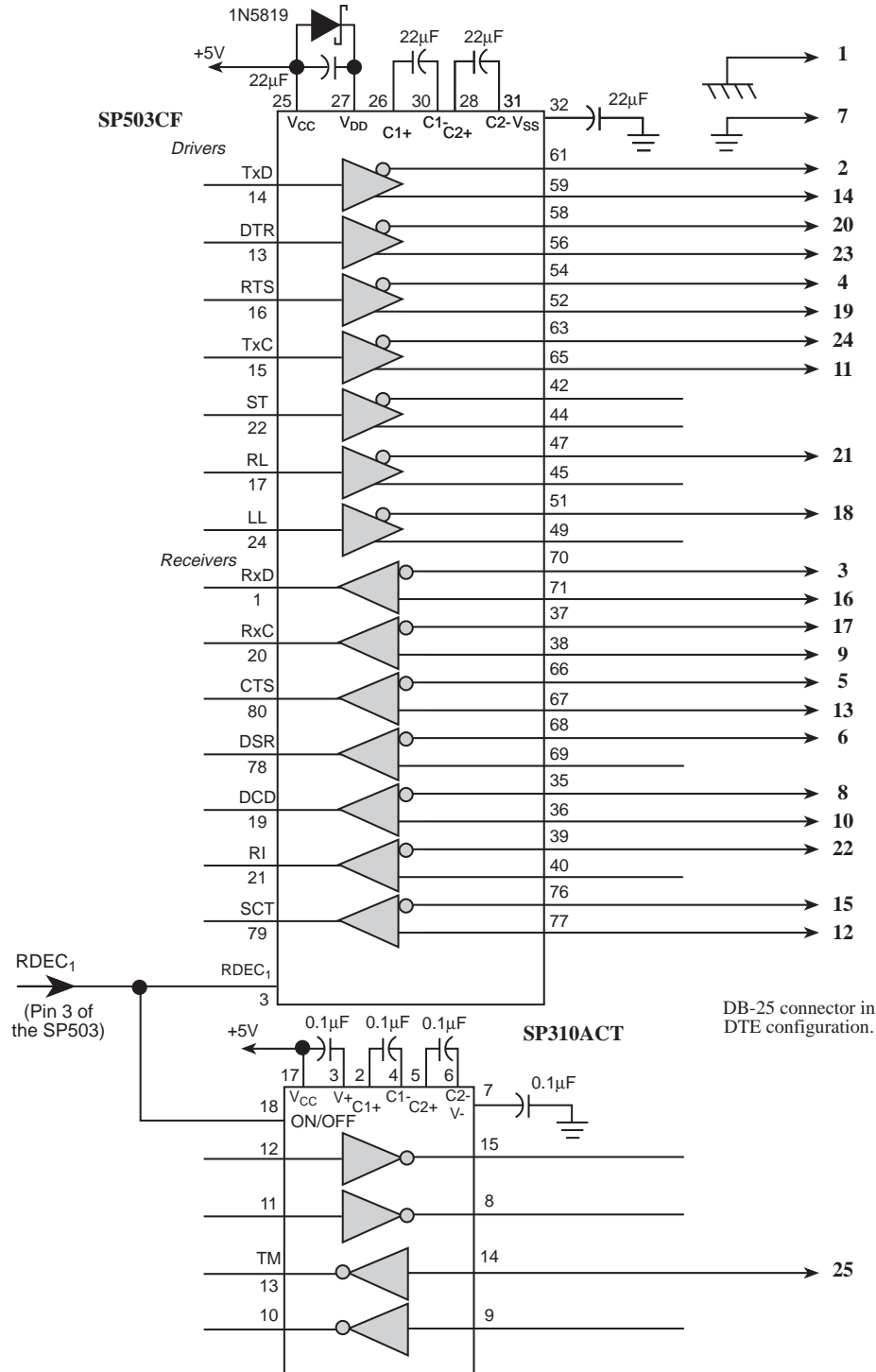**AVX Corporation • Myrtle Beach, SC • 803-448-9411**

The drawing on page 232 shows the **SP503** configured with the ProTek SM16LC15C TVS devices to protect the drivers and receivers from ESD and over-voltage.
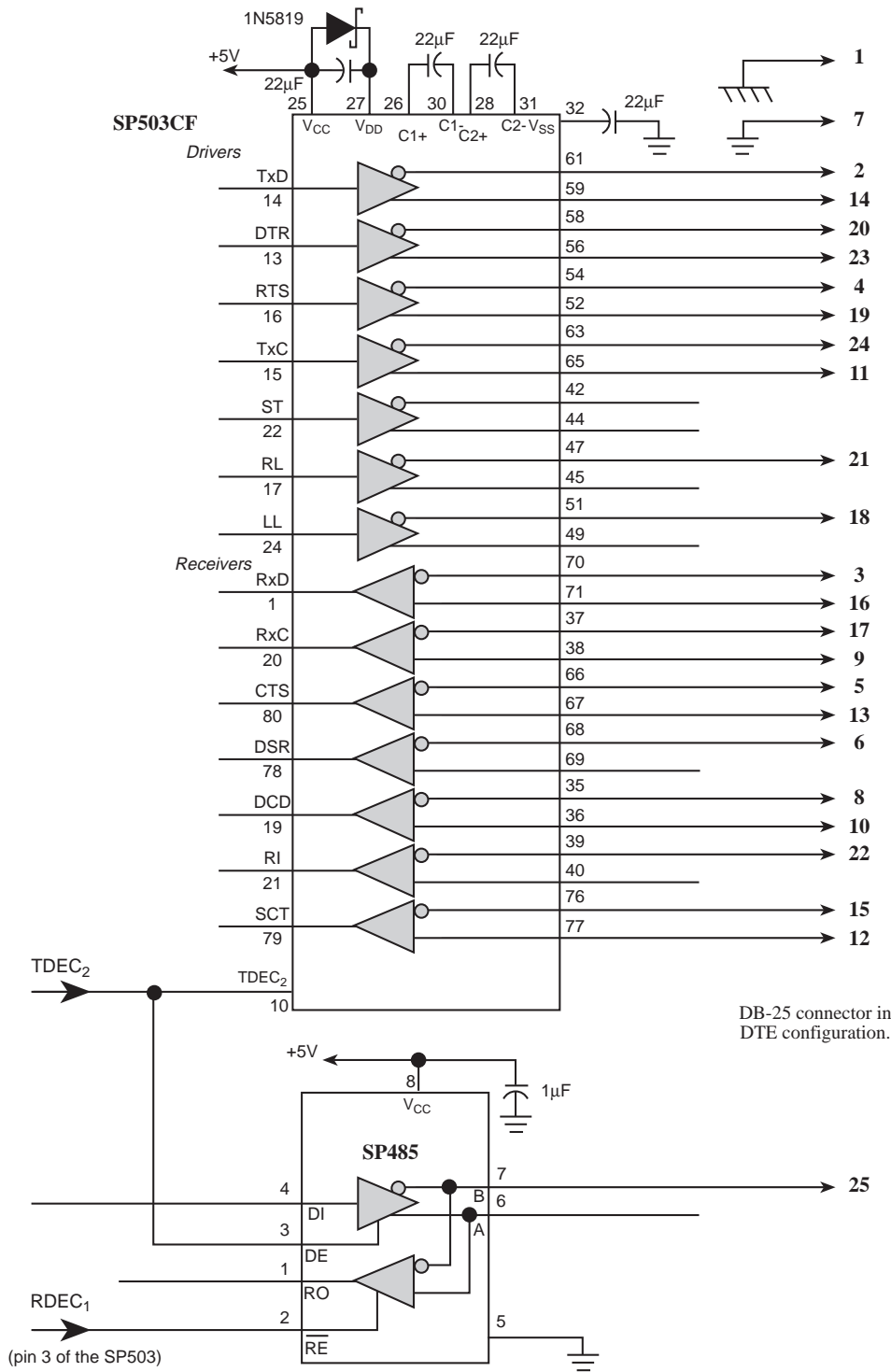
Will the **SP503** conform to the physical layer testing specified by NET1/NET2 for X.21 and X.25 systems?
Sipex initiated a component level test for NET1/NET2 for V.28, V.10, V.11, V.35 protocols. The **SP503** passed all the physical layer testing requirements prescribed by NET1/NET2. A full test report can be furnished upon request.
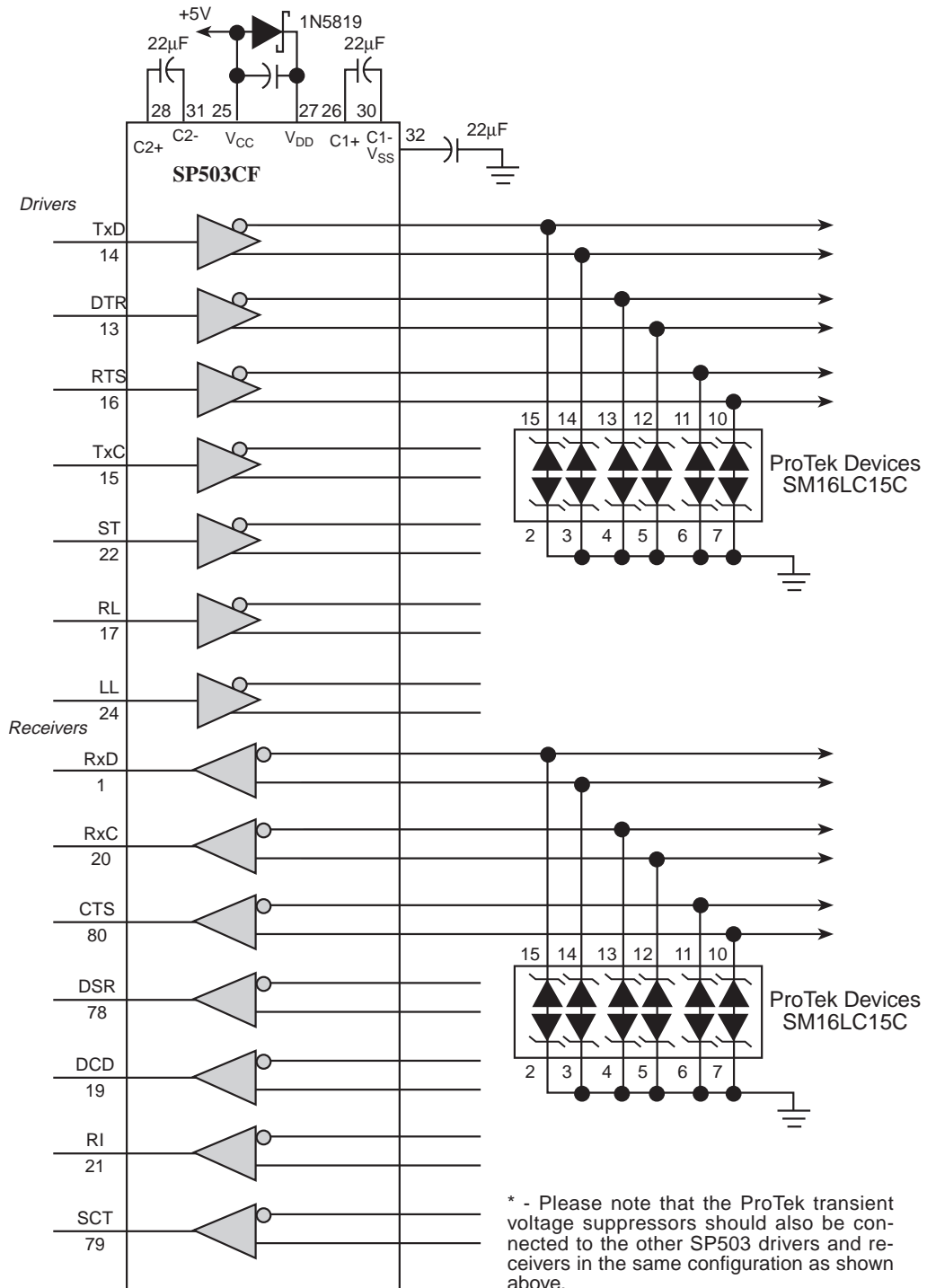
Creating extra RS-232 channels using the SP310A

Creating extra differential channels using the SP485

DB-25 connector in DTE configuration.

Using Transient Voltage Suppressors with the SP503

Drivers

TxD 14
DTR 13
RTS 16
TxC 15
ST 22
RL 17
LL 24

Receivers

RxD 1
RxC 20
CTS 80
DSR 78
DCD 19
RI 21
SCT 79

+5V   1N5819

22µF   22µF

28 31 25   27 26 30   32   22µF

C2+ C2- V$_{CC}$ V$_{DD}$ C1+ C1-   V$_{SS}$

SP503CF

15 14 13 12 11 10

ProTek Devices
SM16LC15C

2 3 4 5 6 7

15 14 13 12 11 10

ProTek Devices
SM16LC15C

2 3 4 5 6 7

* - Please note that the ProTek transient
voltage suppressors should also be con-
nected to the other SP503 drivers and re-
ceivers in the same configuration as shown
above.

ORDERING INFORMATION		
Model	**Temperature Range**	**Package Types**
SP503CF .... 0°C to +70°C .... 80–pin QFP		
SP503EB ....SP503 Evaluation Board		

Sipex

Corporation

SIGNAL PROCESSING EXCELLENCE

Sipex Corporation

Headquarters and
Sales Office
22 Linnell Circle
Billerica, MA 01821
TEL: (978) 667-8700
FAX: (978) 670-9001
e-mail: sales@sipex.com

Sales Office
233 South Hillview Drive
Milpitas, CA 95035
TEL: (408) 934-7500
FAX: (408) 935-7600